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# Efficient and broadband nanoantenna coupler to plasmonic slot waveguide

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Plasmonic slot waveguides [1] provide both field confinement and reasonable propagation length. That makes them promising for high-density optical circuits and interconnects [2-3]. However, small size of the slot waveguide mode makes difficult to couple light to it from thick waveguide, e.g., optical fiber. There was proposed by Wen et al. [4] and Huang et al. [5] to use a dipole antenna for this purpose. However, as this is known from the microwave antenna theory [6], just a single dipole antenna does not provide the maximal coupling efficiency (CE) due to low directivity. Moreover, in the works [4-5] the gap of the antenna was made to be the same as the width of the plasmonic waveguide.

In our presentation we show the substantial improvement of the nanoantenna coupler with the broadband coupling efficiency close to maximal possible if one uses tapered connectors between the nanoantenna and waveguide and additional reflectors (see Fig. 1(a)).

The nanocoupler design is presented in Fig. 1(a). It is made from gold and embedded in silica. It consists of the nanoantenna and side and top reflectors. The performance of the nanocoupler is shown in Fig. 1(b), which shows the flow of the Pointing vector from the excitation fiber to the plasmonic waveguide. Simulation and nanocoupler optimization were made in CST Microwave Studio.

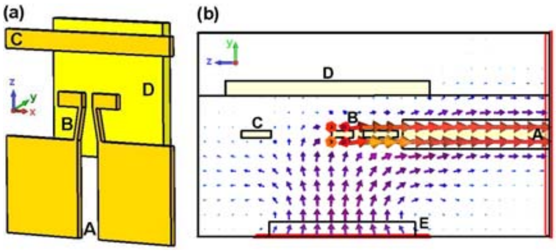


**Fig. 1**: (a) Nanoantenna coupler components: A – plasmonic waveguide, B – nanoantenna, C – side reflector, D – top reflector, E – excitation fiber; (b) nanocoupler in action: power flow from an excitation fiber to the plasmonic waveguide.

Coupling efficiency of the direct fiber-waveguide excitation is below 1% (Fig. 2) at the telecom frequency 193 THz ($\lambda_0$=1.55 μm). Using the optimized nanoantenna increases CE to 17%. Adding to nanoantenna the side and top reflectors brings efficiency to 35%, which is close to theoretical maximal limit of 50% [6]. Moreover, CE spectrum width at half-maximum is 107 THz that corresponds to relative bandwidth of 51%.

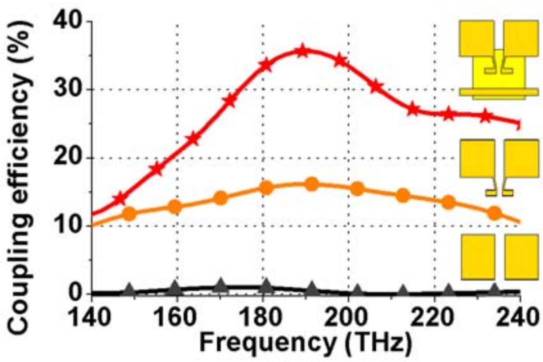


**Fig. 2**: Coupling efficiency without nanoantenna (triangles), with just nanoantenna (circles) and with nanoantenna, side and top reflectors (stars).

Experimental characterization of the nanocouplers fabricated with electron-beam lithography will be presented at the conference.

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